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Helix Anchor Tests
Timmins T.S.

R.H.K. Tsang

Field load tests were performed to confirm the design capacity of foundations at Timmins TS. Compression load tests were performed on two PIFA helix anchors installed along the proposed firewall. Both test anchors indicated acceptable capacity and settlement deflections. However, some difficulties encountered during anchor installation are discussed.

1.0 INTRODUCTION

Due to difficult soil conditions encountered at Timmins TS, ie. the presence of mine tailings and peat under the T2 transformer, two field load tests were conducted to verify the expected capacity of the proposed foundations. At the request of Mr. F. Mammoliti, two production PIFA helix anchor foundations (6" diameter) were proof tested to twice the design load at the location of the proposed firewall. In this manner, these test piles will later serve as part of the firewall foundation. The test method and results are discussed.

2.0 FIELD WORK PERFORMED

The subsoil investigation and evaluation at Timmins TS has been performed and presented in Geotechnical and Hydraulic Engineering Department Report Number 87118. Figure 1 shows the borehole locations at the site. Borehole TTS-3 is positioned closest to the two test anchors currently installed. The geotechnical data sheet for TTS-3 is attached in the Appendix.

The two PIFA test anchors, denoted as Footing #3,#4, were installed in their "final" position along the proposed firewall as shown in Figure 2. The locations marked as #1 and #2 were inaccessible at the time of anchor installation, thus locations #3 and #4 were used for testing the helix

anchors. The field test consisted of proof loading, in compression, the PIFA helix anchors installed in location #3 and #4 to verify their capacity.

3.0 METHOD OF TESTING

A schematic of the set-up for the PIFA proof load test is shown in Figure 3. A compressive load is applied to the PIFA test anchor by means of a jack and reaction beam. The four reaction anchors, HS-11, resist any uplift movement of the I-beam.

Due to limitations of working space, the reaction anchors were installed as follows:

Test Anchor	4 Reaction Anchors (HS-11)
#3	Located 4.2 m centre-to-centre at opposite ends of the I-beam
#4	Located 2.4 m centre-to-centre of PIFA and 2.1 m centre-to-centre of PIFA

The design load specified for the PIFA anchors was 110 kN (25 kips). The two PIFA helix anchors were tested to 220 kN (50 kips) in 22.25 kN increments. A load of 110 kN was held for 10 minutes during the tests. The settlement/anchor movement was monitored for the PIFA and reaction anchors. The test data is presented in the next section. Details of the test method are contained in the Appendix.

4.0 OBSERVATIONS

Both helix anchors, PIFA and HS-11, were installed with a radial boom truck (RBD) equipped with a Commander II boom and a Mark IV digger head. Table I summarizes the installation depths of the Chance anchors. The reaction anchors, HS-11, were installed to a maximum depth obtained by the Commander II with a maximum torque of 14.9 kN.m to 16.2 kN.m (11000 to 12000 ft.lbs.).

The installation torque for PIFA anchors #3 and #4 is shown in Figure 4. Again, the maximum torque was applied during the installation of the PIFA anchors to obtain the measured maximum depths. It should be noted that between 5 to 7 m(16 to 23 ft), the installation torque is a minimum, indicating the presence of the weak peat layer.

Occasional large stones and cobbles were encountered at the site which could pose a problem for other helix anchors to be later installed at a batter. Also, some driven wood piles were encountered at a depth of 10 to 12 m near the existing adjacent transformers (T2 and F5). Mr. B. Flinsky, construction foreman, indicated driven wood piles were installed underneath the existing transformers. Some wood cuttings of pressure-treated wood piles were recovered in the lead section of the HS-11 anchors upon their removal.

The driven wood piles tend to seize or bind-up the installation/penetration of the helix anchors and may prevent the PIFA anchors from reaching their design depth and capacity.

It should be noted that the installation depth of the PIFA anchors (#3 and #4) were 8.5 and 8.8 m respectively (Table I). The required design depth was 13.3 m and 10.4 m respectively for these anchors. However, measurements of the installation torque for both anchors indicated a maximum of 15 to 16 kN.m was applied without further penetration of the anchor into the compact sand at depth (Figure 4).

The load-settlement curves are shown in Figures 5 and 6 for the respective anchor tests #3 and #4. At the design load of 110 kN, an immediate settlement of 1-2 mm occurred. The 10-minute hold did not indicate any creep behaviour of the test anchor. At the maximum load (220 kN), 3-5 mm of settlement occurred. Upon unloading, 50% recovery of the maximum settlement occurred with a permanent set of approximately 1.5 to 2.5 mm. The compressive capacity for both PIFA test anchors were obtained, provided the installation of the anchor was in the dense-bearing layer at depth requiring the maximum torque of 14.9 to 16.2 kN.m (11000 to 12000 ft.lbs). The small deflections/ settlements for both test anchors are acceptable at the design load levels.

5.0 INSTALLATION DIFFICULTIES

Some difficulties were encountered at the test site during installation and testing of the helix anchors. Subsequently, delays resulted due to:

(1) Limited working space.

(2) Live/operational transformers and overhead lines directly adjacent to the test site.

(3) Location and clearance of live underground cables and buried oil pipelines.

(4) Replaced oil lines and repaired oil leaks on Commander II.

(5) Locating parts for Mark IV and HS-11 driving tool/adapter.

(6) Torque indicator gauges malfunctioned during installation of the PIFA anchors.

(7) Cleaned PIFA anchors in preparation for applying Carbomastic #14 to exterior of anchor shaft.

A further note regarding the transformer foundations to be installed should be made. An excavation of approximately 2 m is required below the existing grade (DWG #FA19-DIS-25440-0001-00) into the loose mine tailings, therefore, adequate bracing/shoring and dewatering may be required at the site.

6.0 CONCLUSIONS

The installation and compressive load tests were performed on two PIFA helix anchors at Timmins TS. These two PIFA anchors were installed along the proposed firewall. The design capacity (110 kN) with 1 to 2 mm settlement was observed from the field load tests and are acceptable for both PIFA anchors (#3 and #4). However, the PIFA anchors were installed to the maximum depth possible using the Commander II, but less than the design depth of 10.4 m and 13.3 m. The installation torque was monitored and a maximum torque of 15 to 16 kN.m (11000 to 12000 ft.lbf.) was applied to the helix anchors. The PIFA anchors (#3 and #4) were installed to a maximum depth of 8.5 m and 8.8 m respectively.

Some difficulties may be anticipated regarding future installation of PIFA anchors due to:

(a) large stones and cobbles at depth, and
(b) wooden piles near the base of existing transformers.

These factors may cause problems during installation; especially helix anchors required at a batter. Also, adequate bracing and dewatering may be required to excavate the loose mine tailings.

ACKNOWLEDGEMENTS

The author is grateful to the Mechanical Research Division, Messrs. G. Senkiw, D. Auston and D. King for performing the load testing and Mr. P. St.Denis for assisting in the arrangements of the testing.

Also, the cooperation and assistance from Mr. B. Flinsky and his crew at Timmins TS was appreciated.

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REFERENCE

1. Timmins TS, Subsoil Investigation and Evaluation, Report No 87118, Ontario Hydro, Geotechnical and Hydraulic Engineering Department, K.L. Cheng, April 30, 1987.

2. Compression Tests on PIFA Anchors - Timmins TS, Report BG87-42-H, Ontario Hydro, Research Division, Mechanical Engineering Department, G. Senkiw, in print.

TABLE I

INSTALLATION DEPTH

Helix Anchor	Installed Depth (m) (Below existing grade)
PIFA Test Anchor #3	8.5 (design depth 13.3 m)
4 Reaction Anchors (HS-11)	
a	10.7
b	14.3
c	14.6
d*	14.6
PIFA Test Anchor #4	8.8 (design depth 10.4 m)
4 Reaction Anchors (HS-11)	
a	14.3
b	11.3
c	14.6
d*	14.6

* Reused same reaction anchor for both tests.

Note - Schematic of testing layout in Appendix.

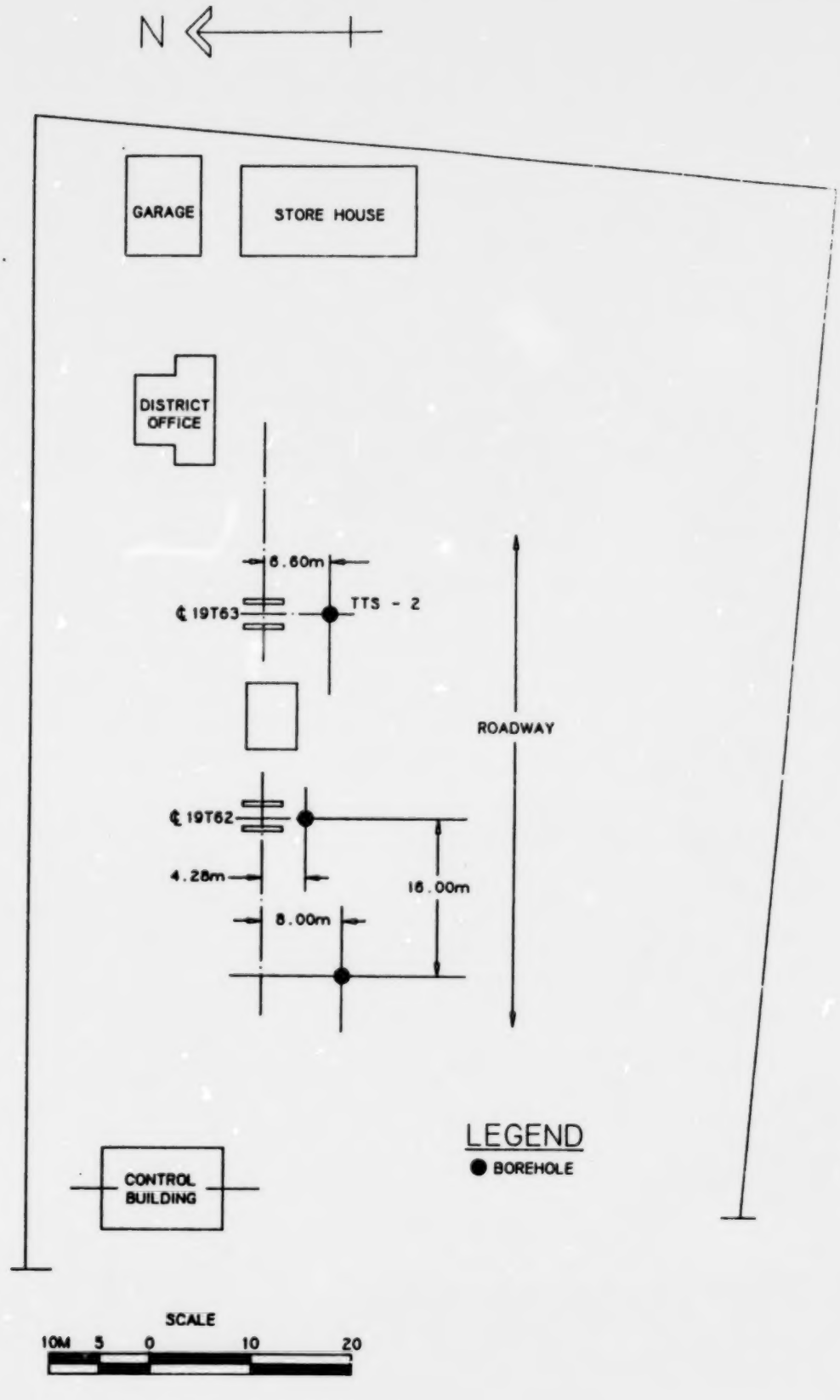

FIGURE 1

TIMMINS TS
BOREHOLE LOCATIONS
FROM REPORT NO 87118

175307-RD
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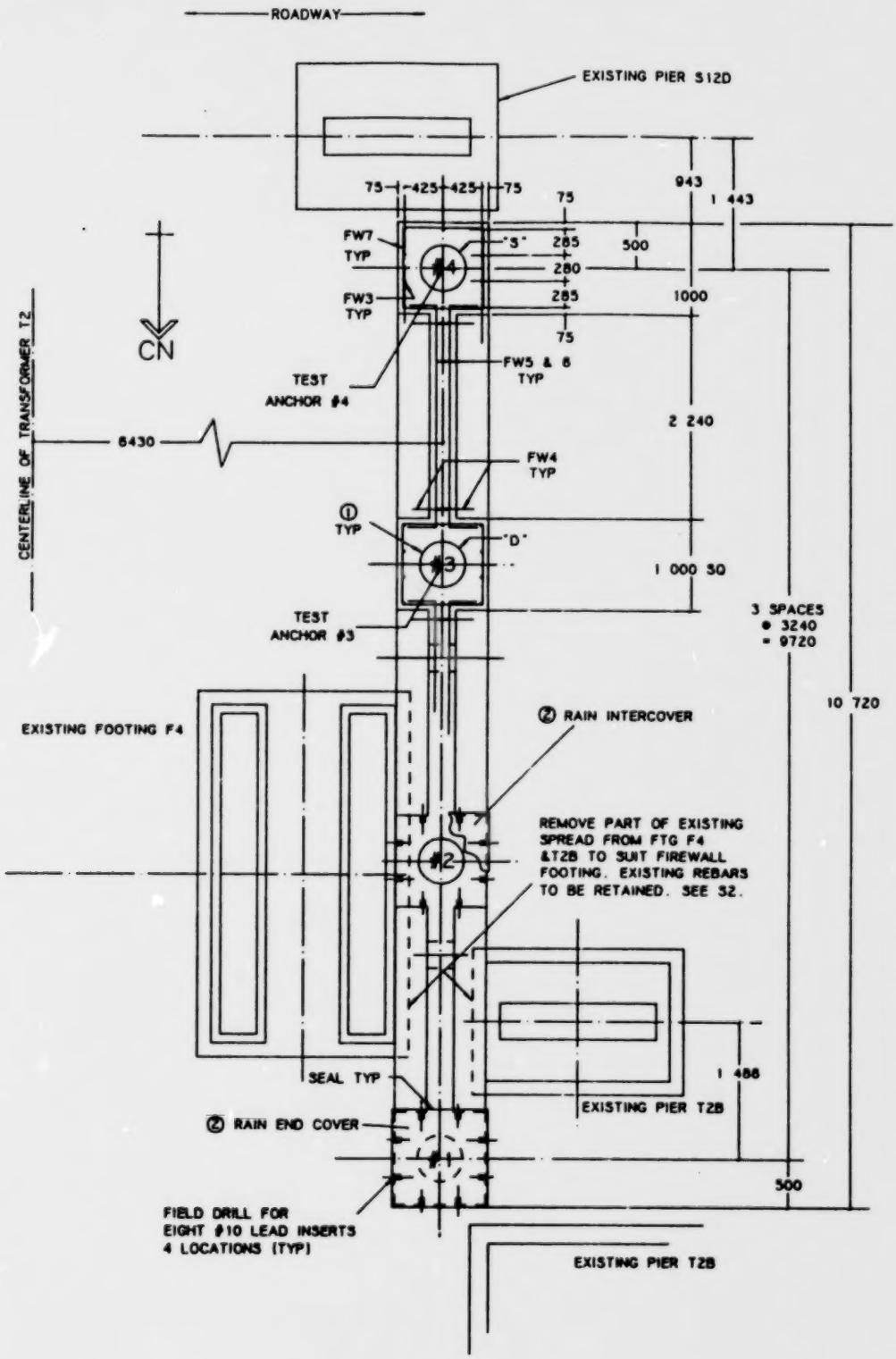

FIGURE 2

TIMMINS TS - 115 kV AREA
TRANSFORMER T2 - FIREWALL 'FW1' FOUNDATION
CONCRETE DETAILS

Refer to Dwg No: FA19-DIS-27890-00010-00
Fa19-DIS-25440-0001-00

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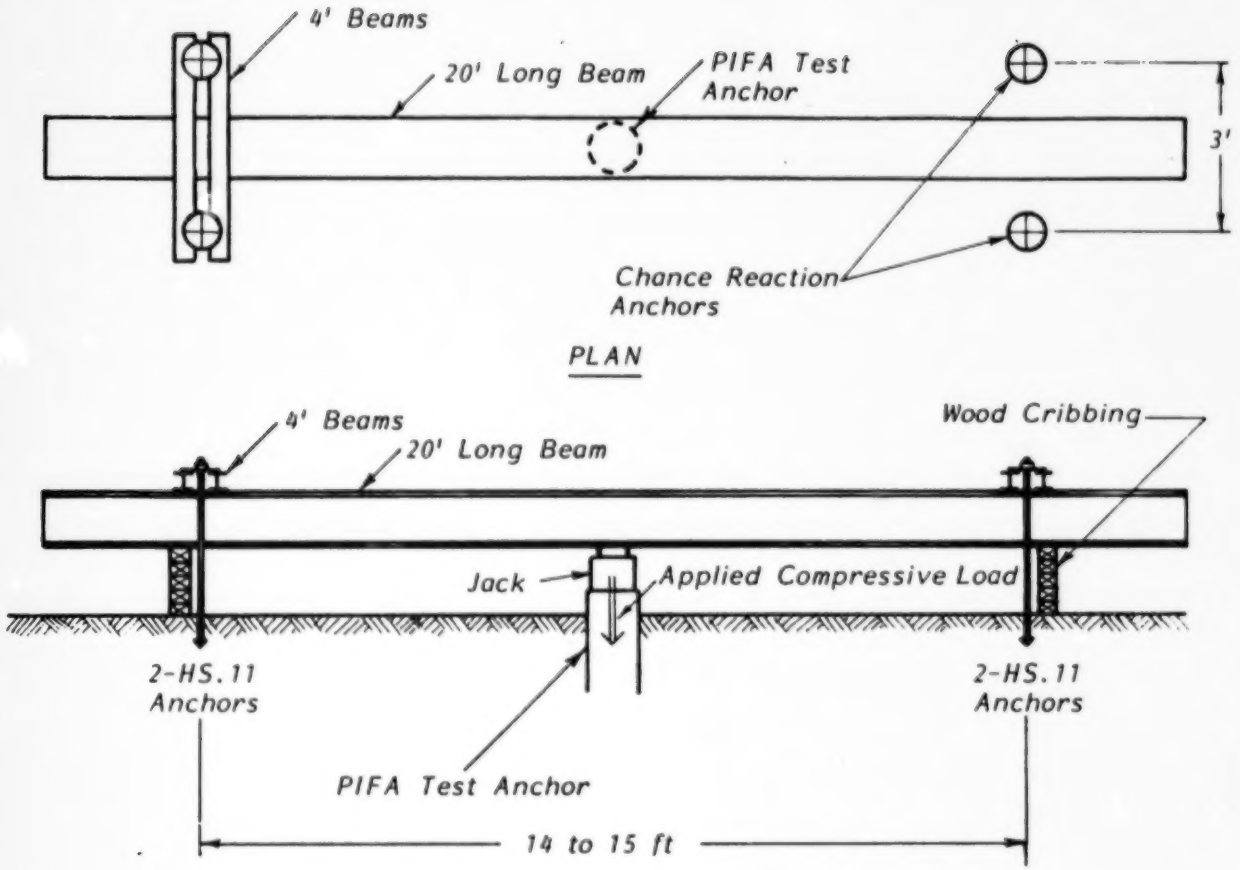
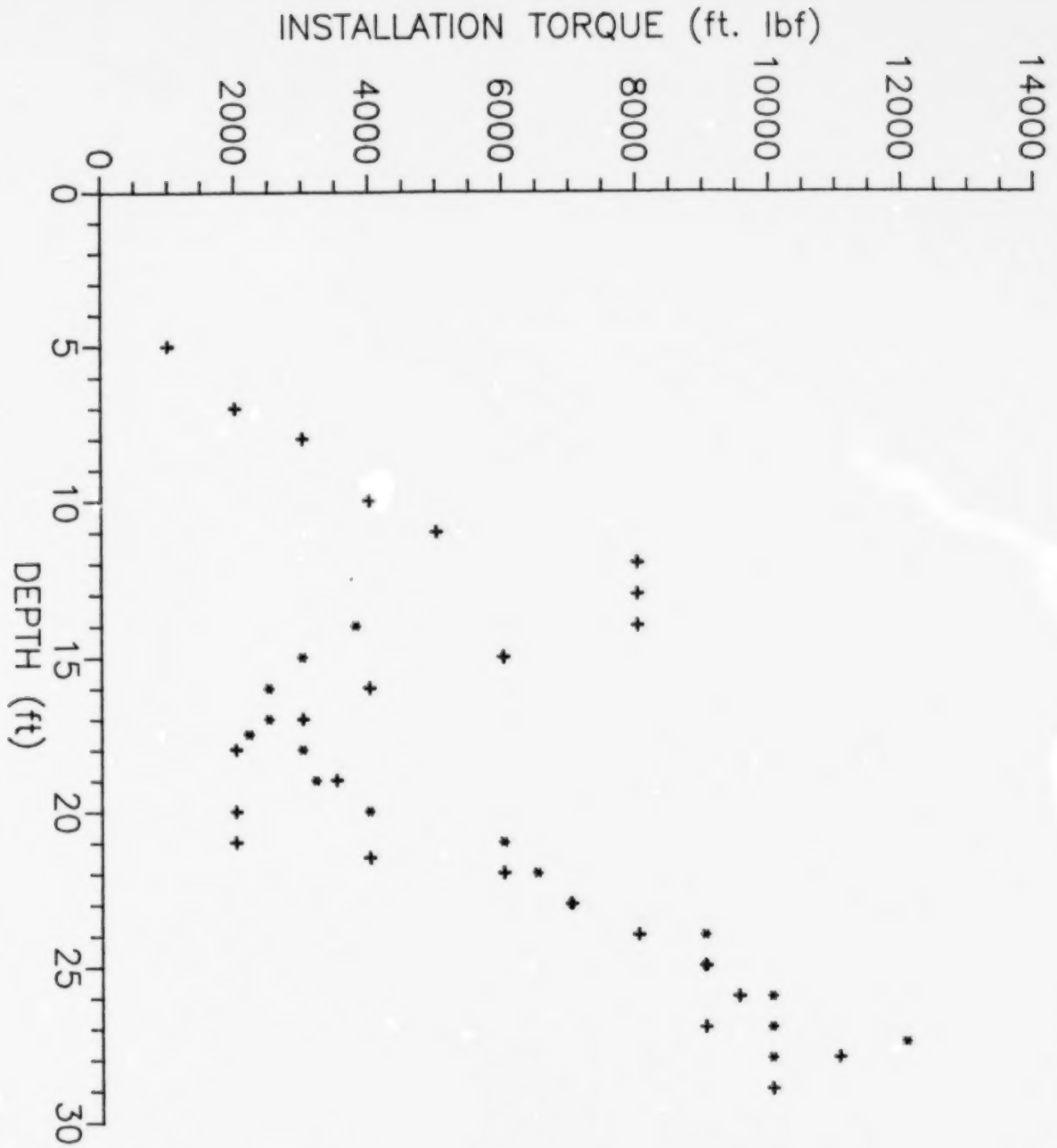


Note: 1 ft = 0.30 m

FIGURE 3

COMPRESSION TEST SETUP FOR TIMMINS TS PIFA PROOF TESTS



* *PIFA Anchor #3 - Installed Depth 28 ft*
\+ *PIFA Anchor #4 - Installed Depth 29 ft*

FIGURE 4
INSTALLATION TORQUE

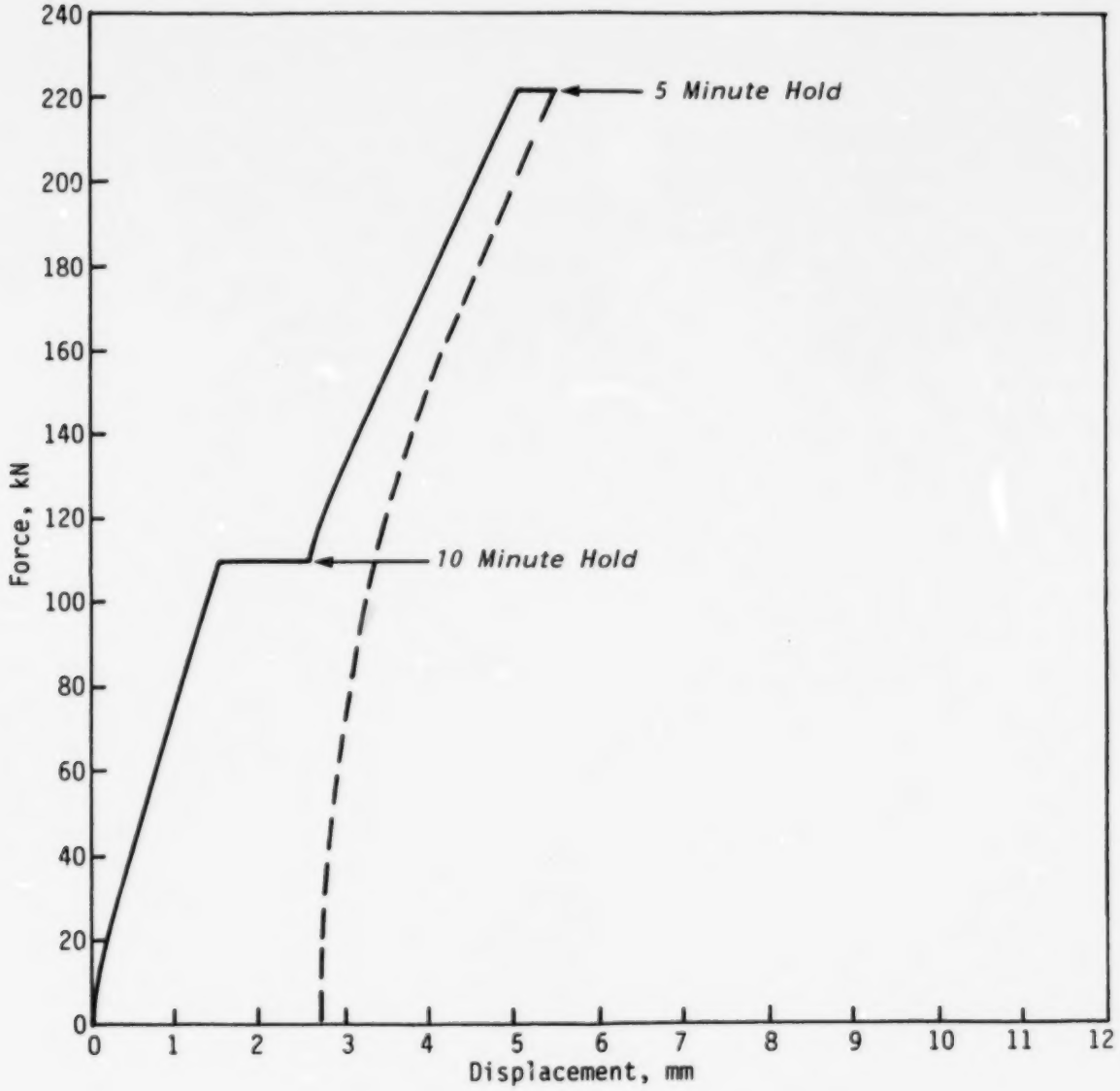


FIGURE 5

COMPRESSION TEST NO.3
ON 6" PIFA ANCHOR

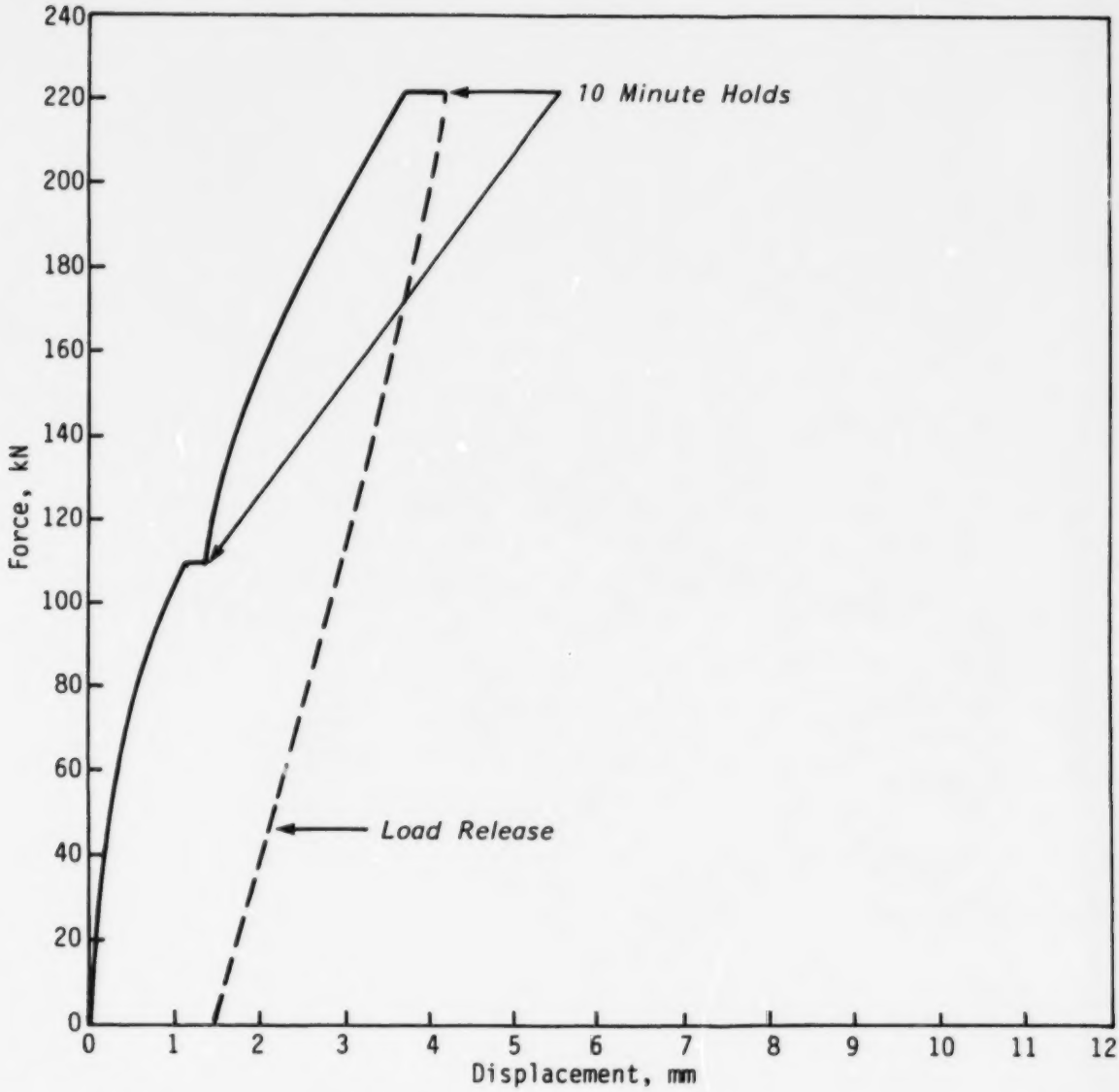


FIGURE 6

COMPRESSION TEST NO.4
ON 6" PIFA ANCHOR

APPENDIX

project TIMMINS TS — hole type AUGER — observer L.H. Adams

location As Shown in Figure 1 — hole size 6.0" HS — compiled K.L. Cheng

dip 90° — drilled 1 - 10 MAR 87 — checked KLC, MH

datum —— — bearing —— — drawn 16 MAR 87 EC/GG — approved O.A. Johnston

borehole data						borehole log	water inf.		field tests		laboratory tests					
scale - metres	elev / depth	sample no.	sample type	'N' value per 0.3m / RQD %	water level and caving	description / remarks	observation well data	'k' soil/rock cm/s / water press. test	special tests type	special tests results	natural density kg/m³	moisture % content	shear strength kPa type	shear strength kPa results	special tests type	special tests results
					W.R.	DATUM = GROUND SURFACE										
						CRUSHED STONE										
1	0.40	1A		19		compact, damp, brown, coarse to fine SAND						6.8				
2	2.00	2A		8		loose, moist, grey SILT/FINE SAND					2199	21.2				
3		3A		12		saturated below 3.0m (Tailings)				Augered		22.7				
4		4A		10								34.9				
5																
6	5.80	5A		6		PEAT: black, fibrous			DC	3		388				
7	6.90					compact, saturated, grey, medium to fine SAND				6						
										6						
										14						
										15						
8		6A		22						16		19.7				
										26						
										24						
9						mostly fine grained below 9.0m				19						
		7A		26						28						
										27		18.1				
10										37						
										32						
						clayey silt seams below 10.8m				35						
11		8A		17						46						
										42		24.3				
										40						
12										36						
										31						
		9A		14						30						
										33		29.3				
13										30						
										28						
										27						
14		10A		12						28						
										33		18.1				
										26						
	14.40					compact, SANDY SILT TILL				36						
15										37						
		11A		14/90mm (Refusal)		(Assumed)				44						
16	15.48					END OF BOREHOLE				14/200mm (Refusal)						

NOTES
1. Borehole backfilled on completion
2. All soil contacts are approximate
3. Water was introduced into augers during augering below 7.8m
4. Dynamic cone penetration test performed adjacent to borehole

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geotechnical data sheet

hole no. TTS-3 — fig. 4

sheet 1 of 1

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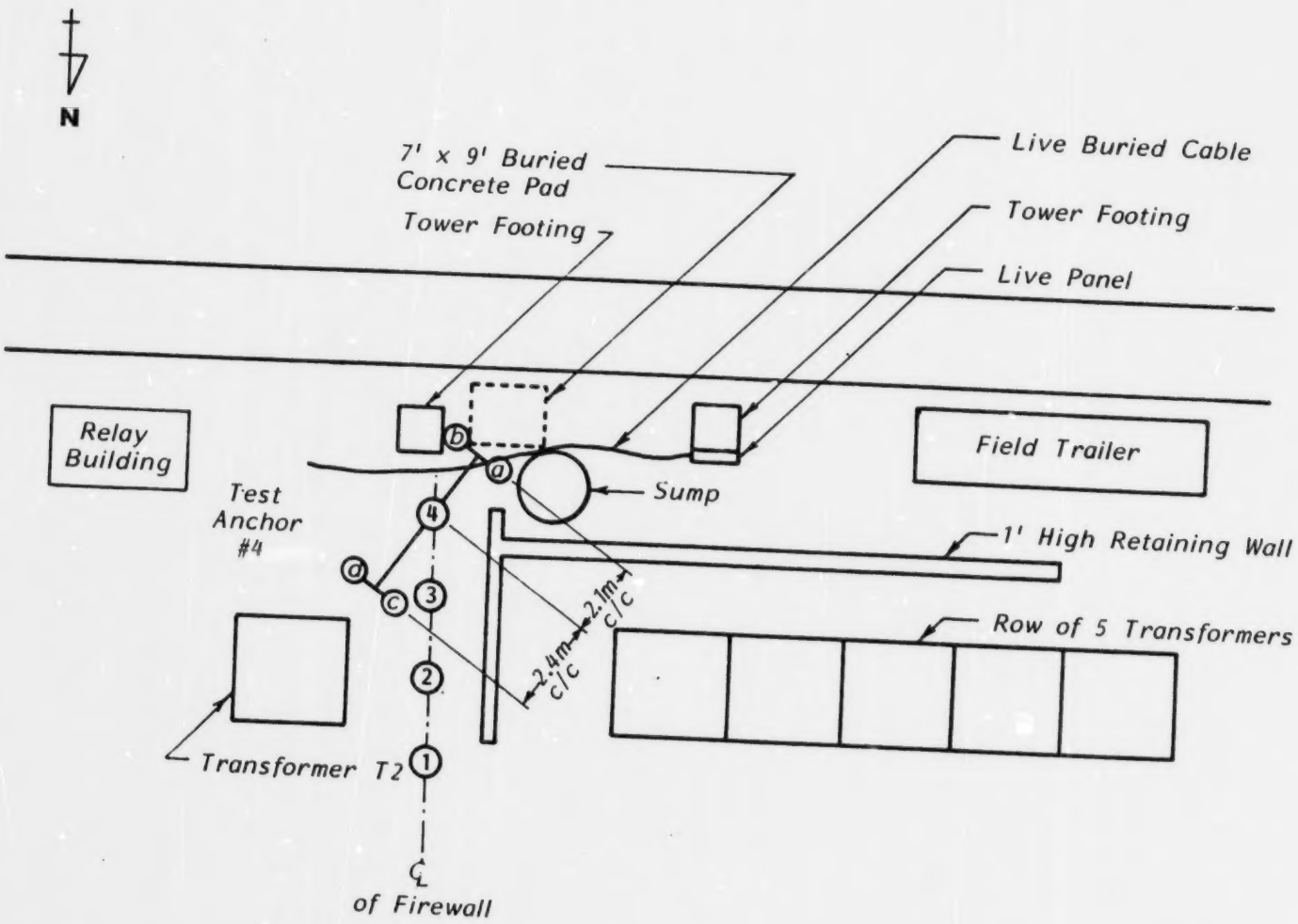

FIGURE A1

SCHEMATIC OF TESTING LAYOUT

Location of Test Anchor #4
Location of Reaction Anchors a, b, c, d

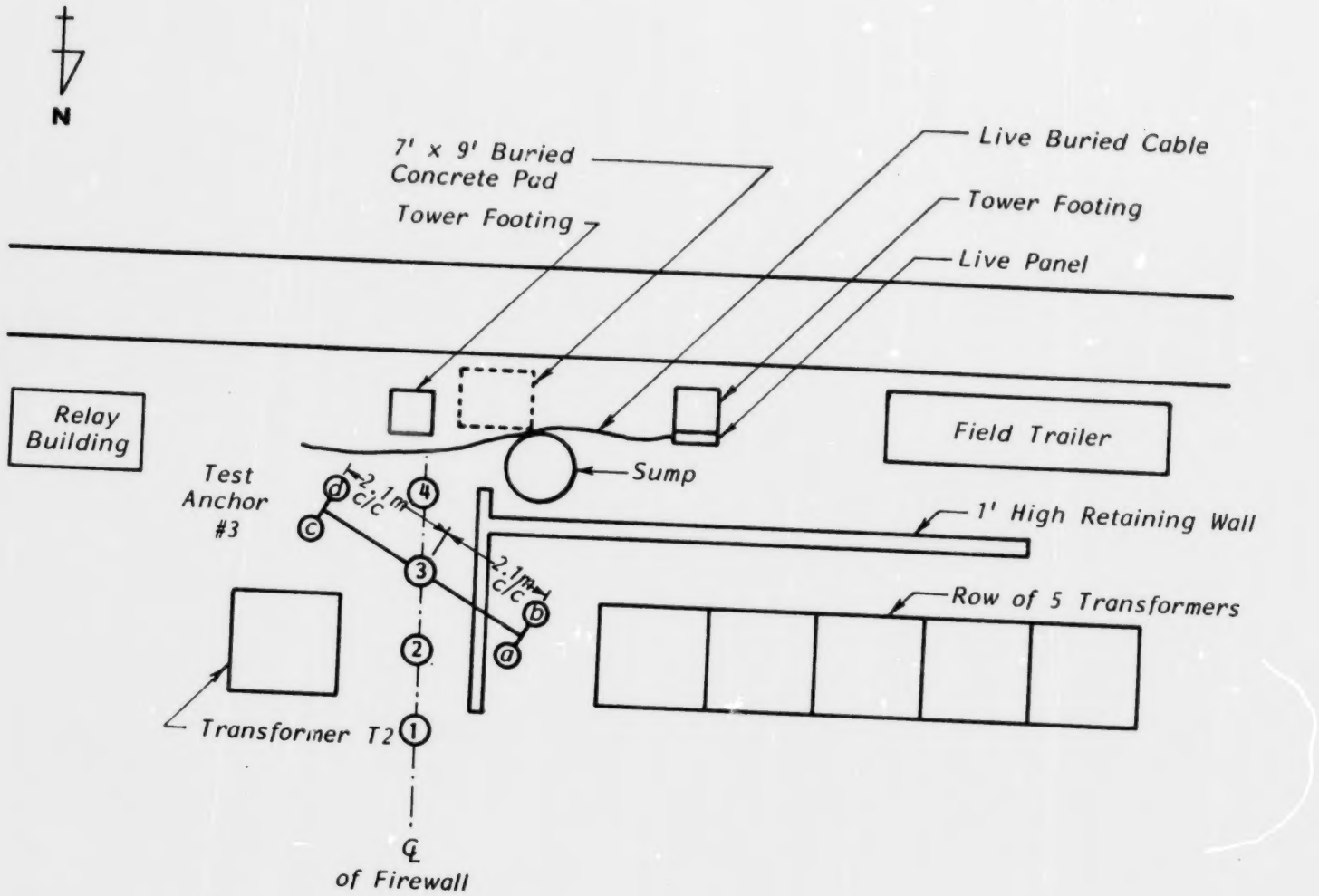

FIGURE A2

SCHEMATIC OF TESTING LAYOUT

Location of Test Anchor #3
Location of Reaction Anchors a,b,c,d

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COMPRESSION TESTS ON PIFA ANCHORS - TIMMINS TS

Proof load compression tests were performed on two 6" PIFA anchors installed at Timmins TS. The anchors will be used to support a transformer firewall at the station. Figure 1 shows the location of the two test anchors as well as the location of the temporary reaction anchors used in the tests. The tests were carried out on June 23 and 24, 1987.

Test Arrangement and Test Procedures

A schematic of the test arrangement for both tests is given in Figure 2. Figures 3 and 4 depict the actual test setups. A 900 kN capacity, hydraulic jack reacting against a 6 m long, 27" W steel beam, supported on a crib of timbers, was used to apply the compression force on the PIFA anchors. For each test, four Chance HS11 anchors provided the reaction restraint for the 27" W steel beam. Table I summarizes the details of the installation of the test and reaction anchors.

The displacement measurements were taken by a dial gauge. The gauge, attached to the PIFA anchors, had its stem resting on a steel batter board which was supported on wood timbers placed well away from the zone of influence. The clear span between the wood timbers supporting the batter board was typically 5 m.

The compression loads to each PIFA anchor were applied in steps of 22 kN (5 kips). At a load of 110 kN - the design load, the load was held for 10 minutes after which the loading was resumed with the same load increments up to twice the design load (220 kN). At twice the design load, the load was again held 5 to 10 minutes after which it was released in two equal steps.

Test Results

The test results are summarized in Table I. Figures 5 and 6 depict the load/displacement curves for Test Nos 1 and 2, respectively. Both 6" PIFA anchors successfully withstood twice their design load with minimum displacement.

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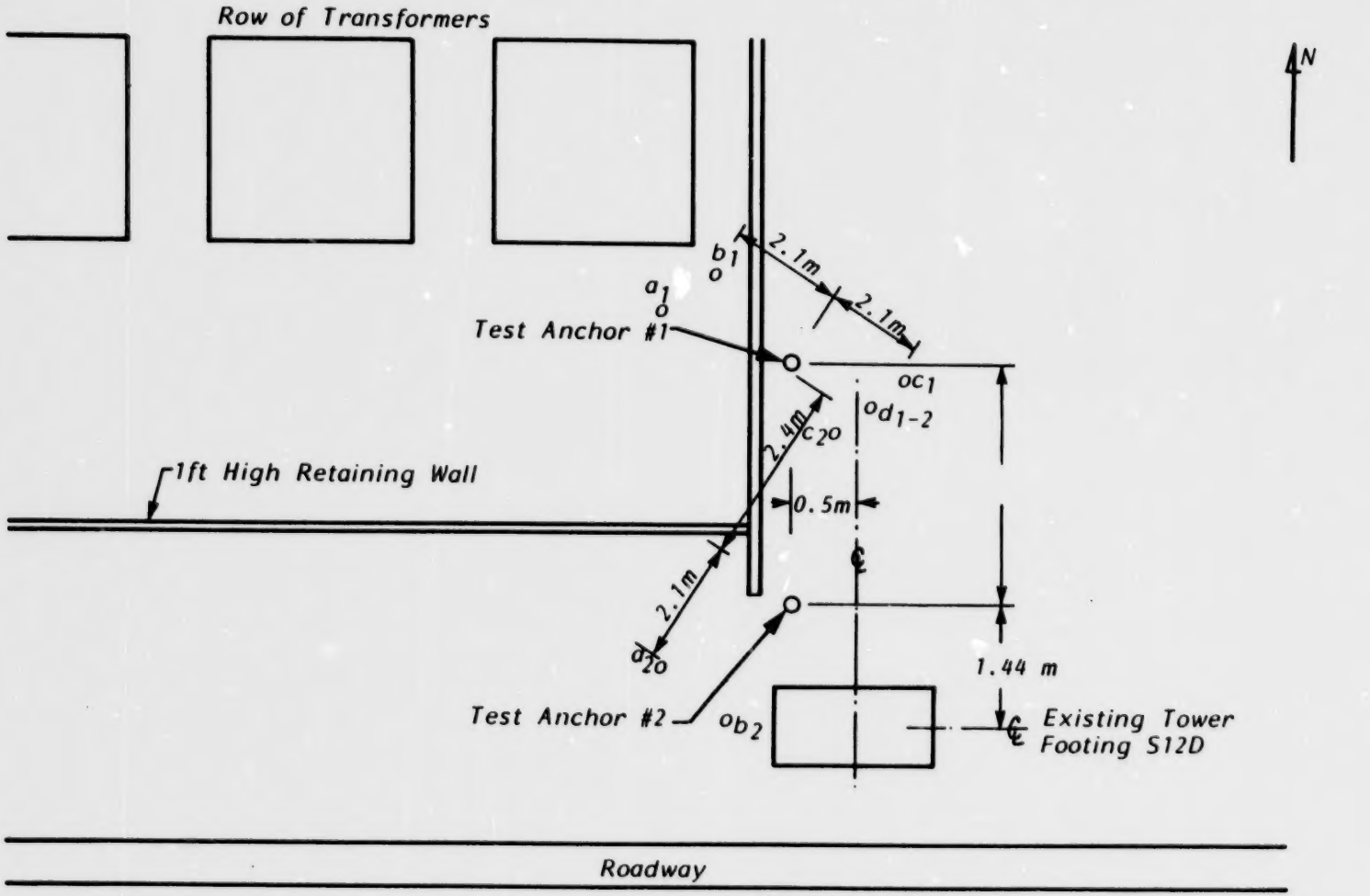
job	file	date	report no.
24-188-40131	824.52	August 19, 1987	BG87-42-H

87-251

TABLE I

SUMMARY OF TEST RESULTS

Test No	Test Date	HS11 Reaction Anchors					6" PIFA Test Anchor			Figure No
		Installed Depth (m)				Clear Span (m)	Installed Depth (m)	Maximum Load (kN)	Resulting Displacement (mm)	
		a	b	c	d					
1	June 23/87	10.7	13.7	14.6	14.6	4.3	8.5	220	5.41	5
2	June 24/87	14.3	11.3	14.6	14.6	4.6	8.9	220	4.09	6



Note: 1) Schematic not to Scale
2) a,b,c,d Temporary Reaction Anchors

FIGURE 1
SCHEMATIC OF ANCHOR LAYOUT - TIMMINS TS

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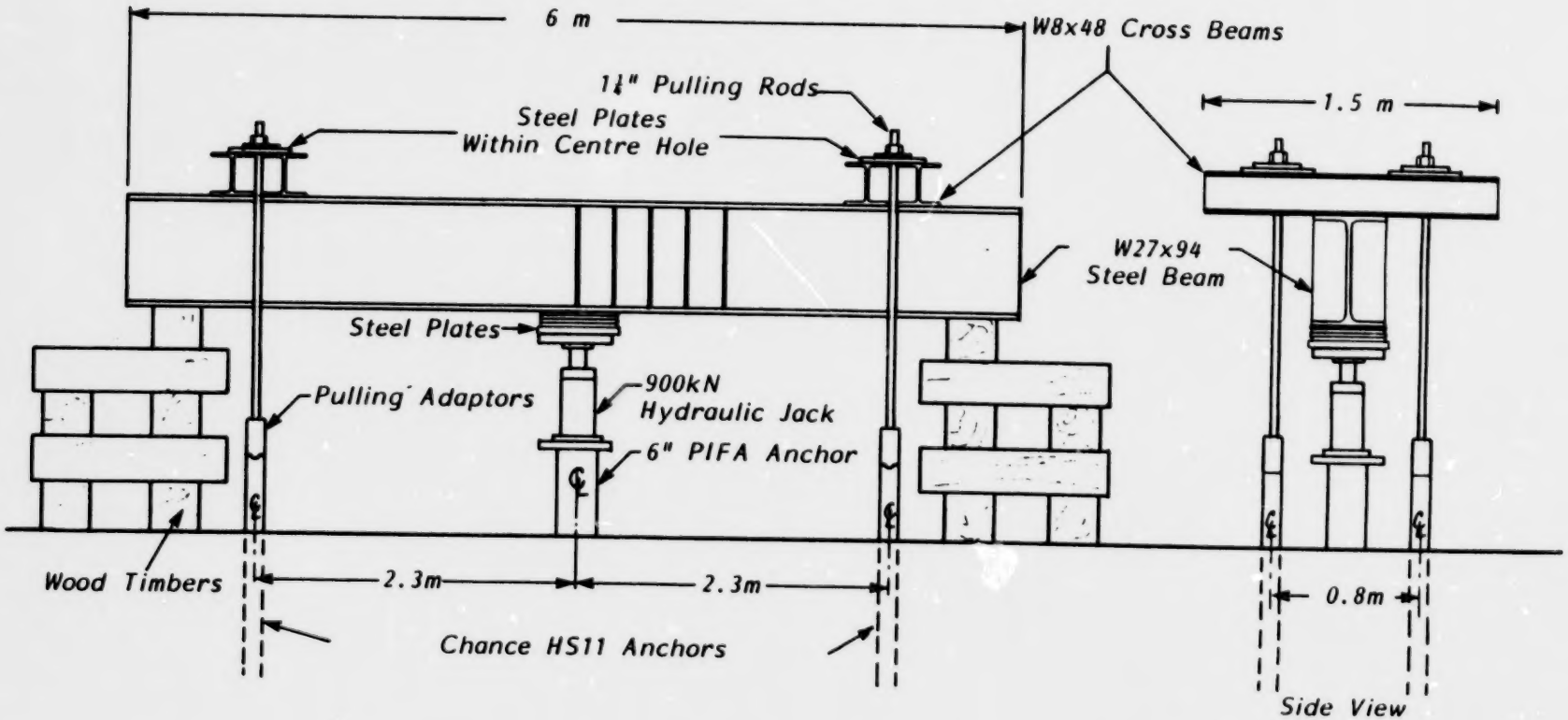

FIGURE 2
COMPRESSION TEST ARRANGEMENT

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87-251

FIGURE 3

COMPRESSION TEST ARRANGEMENT
ON 6" PIFA ANCHOR

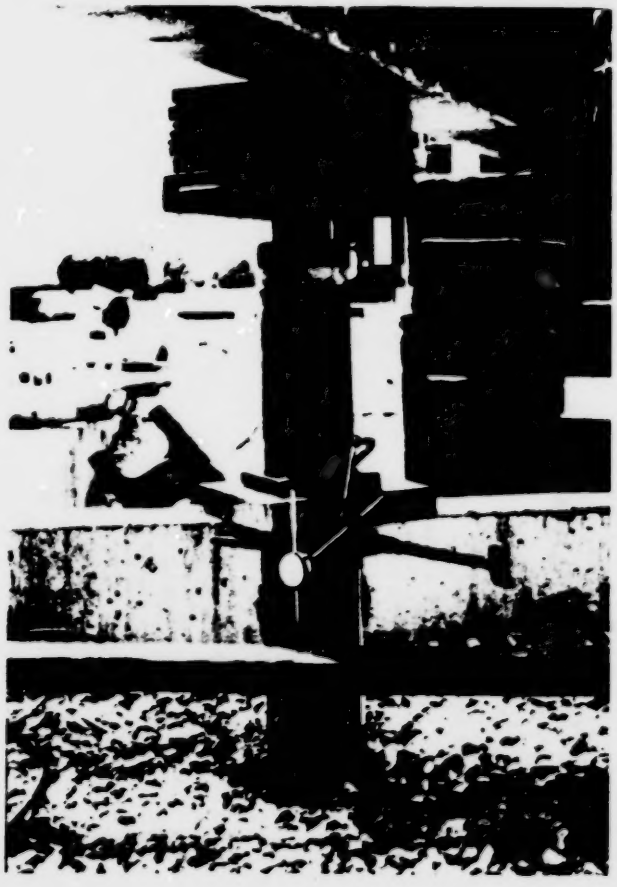

FIGURE 4

CLOSE-UP OF HYDRAULIC
JACK AND DIAL GAUGE

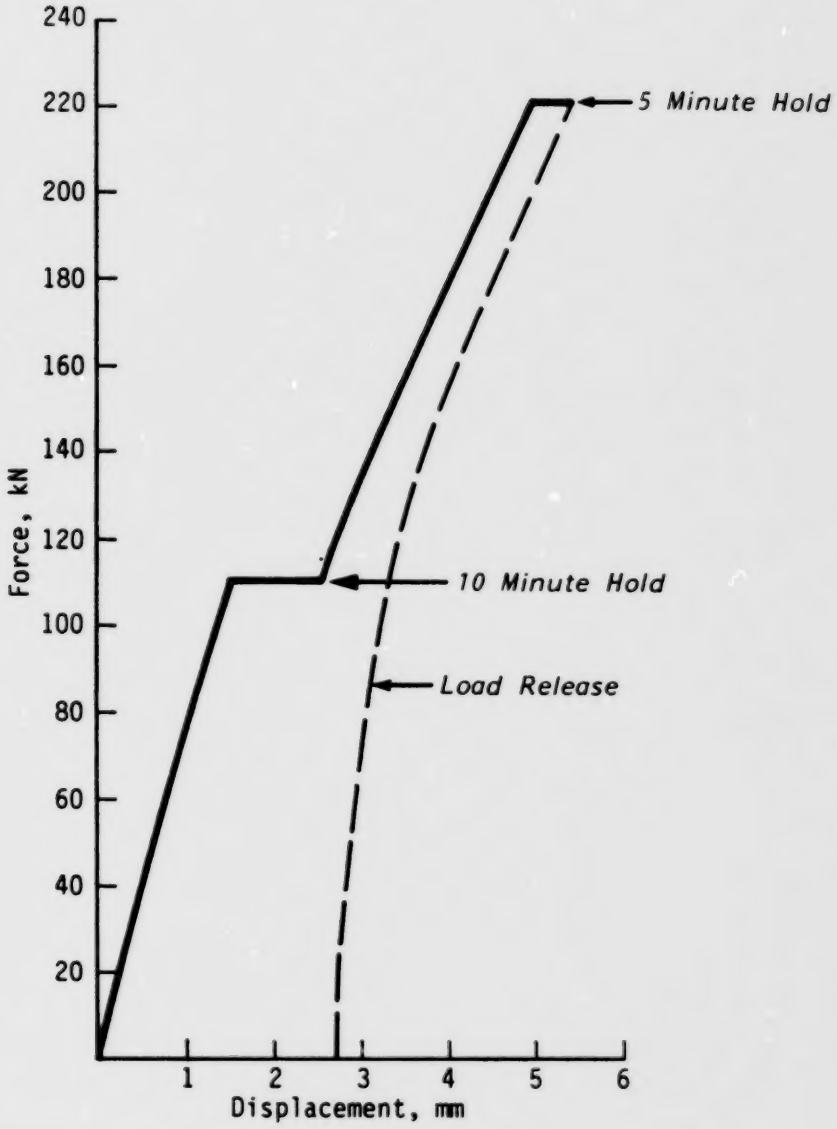

FIGURE 5

COMPRESSION TEST NO 1
ON 6" PIFA ANCHOR

175345-RD

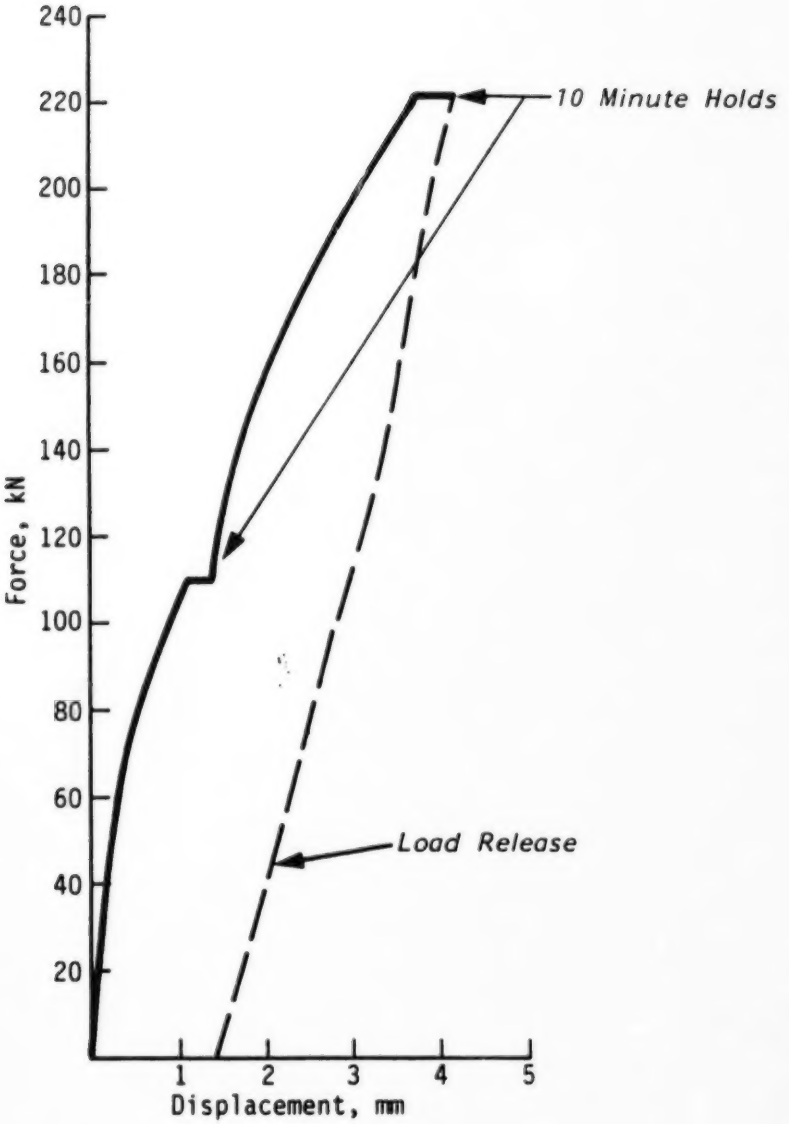

FIGURE 6

COMPRESSION TEST NO 2
ON 6" PIFA ANCHOR

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